



# Inclusion of invertebrates in rehabilitation performance measures and minesite completion criteria

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# Some recent rehabilitation





How will it look when it matures? Is the task complete?



# Need for completion criteria

- **Industry** – require indicators of success with rehabilitation to determine when liability for the site ceases
- **Government agencies** – to ensure they are not inheriting ongoing liability
- **The public** – to know that the rehabilitation has been successful and is sustainable

# Some underlying principles

- Area is safe
- Meets land use objectives
- Exhibits sustained growth and development
- Has vegetation that is as resilient as the original community
- Can be integrated with local management practices



# Completion criteria measures tend to be highly generic

- Area is safe
- Has appropriate landform
- Is free from erosion
- Attained a certain vegetation cover
- Reaches a required number of plant species per quadrat
- Contains animal habitat

# But . . . . .

- Plants may not be pollinated
- Next generation seeds may not be dispersed and 'planted'
- Insufficient plant recruitment
- Nutrient cycling may be inadequate
- Appropriate soil structure may not form
- Pest outbreaks may destroy plants
- Succession may 'fail'
- Etc., etc.

# World's best practice





# Invertebrates in Completion Criteria



- Terrestrial invertebrates are extremely diverse, with an estimated 250,000 in Australia, compared with 9,088 chordate and 23,845 plant species.
- They participate in all ecosystem functions and processes, including soil structuring, nutrient cycling and pollination, as well as providing food for vertebrates.

# Invertebrates in Completion Criteria

- They have been described by Prof Ed Wilson as 'the little things that run the world'.
- Since the majority of species have specialized requirements, their presence or absence tells us much about the conditions of the environment that we are looking at.

# Bioindicator potential of invertebrates

- Assessment of the species present in an environment therefore provides an excellent picture of the diversity and environmental 'condition' or 'health' of an area.
- It can answer questions such as:
  1. Is nutrient cycling happening?
  2. Is an appropriate soil structure forming?
  3. Are all plants likely to be pollinated?
  4. Is the area starting to resemble the original ecosystem?



# Which ones could we use?

- **Problem** - Invertebrates are so diverse that we have to select a manageable group or subset.
- Ideally, the group should be:
  1. Ubiquitous;
  2. Easy to sample;
  3. Diverse, leading to high statistical value;
  4. Responsive to environmental changes in predictable ways;
  5. Reflective of the diversity and composition of other groups.

# Shopping basket of roles



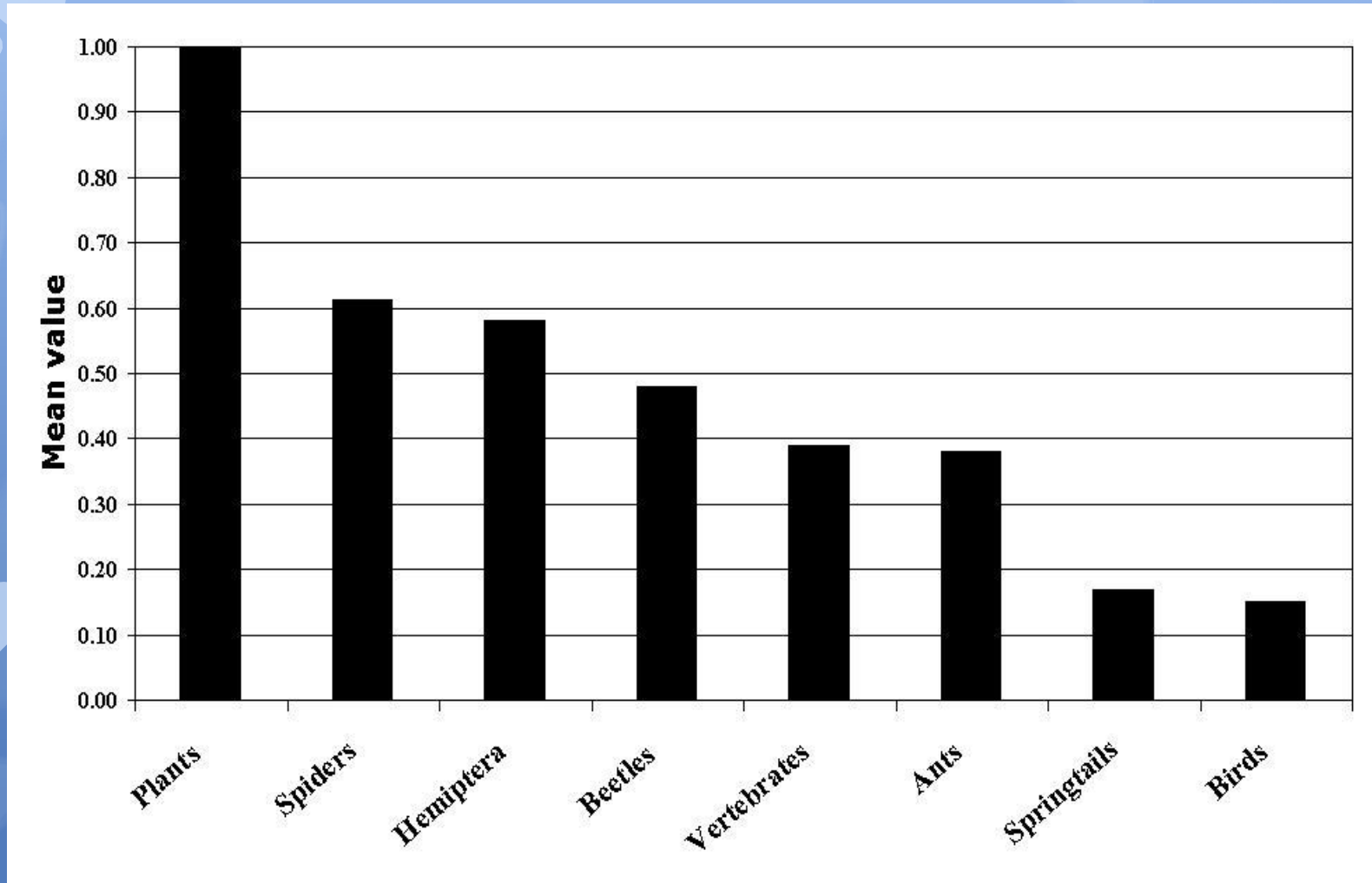
**Decomposer**

**Herbivore**

**Predator**

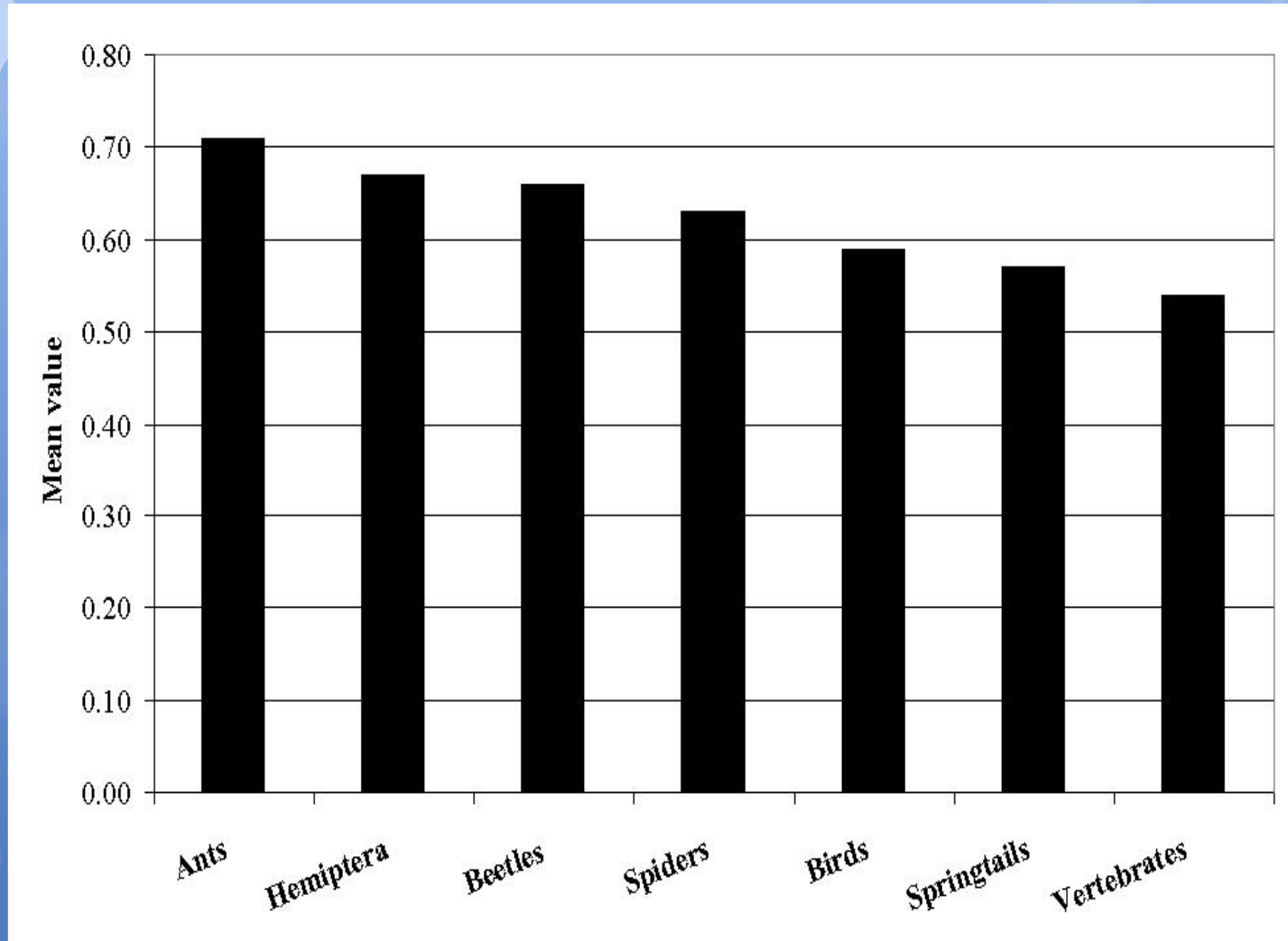
**All-rounder**

# Ability of the taxon to track changes in the environment





# Ability of the taxon to track changes in other taxa



# Data yield

Time x Effort = \$\$\$

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Taxon	Number of species per hr
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Hemiptera	3.67
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Beetles	3.34
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Plants	3.10
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Spiders	2.99
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Ants	2.94
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Birds	2.42
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Springtails	0.87
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Isopods	0.43
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Vertebrates	0.43
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Myriapods	0.29
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# Candidate groups for our shopping basket

- Ants –predators, seed feeders, sap feeders
- Spiders -predators
- Sucking bugs (hemipterans) -herbivores
- Beetles – diverse feeding habits
- Bees - pollinators
- Termites - decomposers



# An enigma !?!?!?



**1000 species**

**20 species**

# Conclusion

- Inclusion of invertebrates in CC would greatly enhance our understanding of the condition of the mine prior to closure.
- It would provide considerably more information on the 'naturalness', biodiversity value and ecological sustainability of the site than the current schedule of CC.
- It would create a favourable impression with regulators and stakeholders by demonstrating that the company is serious about measuring the degree of completion following mining.

# Biomonitoring International specialises in this type of work

- Invertebrate sorting laboratory
- Pitfall traps and Winkler sacks for sampling ground and litter
- Sweep nets and vacuum machines for sampling vegetation
- Motorised mistblower and nets for sampling trees
- Light traps and nets for day and night flying insects
- Entomological library
- Full component of Leica stereo microscopes and sorting equipment



The background of the slide is a blue gradient with numerous light-colored circular spots. Overlaid on this background are many ants, shown from a top-down perspective, scattered across the frame. The ants are dark brown or black and appear to be moving in various directions.

Thank you!

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